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ABSTRACT

This paper examines the benefits of a metaphorical graphical user interface (GUI) and discusses how metaphorical interfaces can be used to deliver instruction on stress management. A computer-based instructional (CBI) program for college students was developed on the fundamentals of stress and the role of time management as a coping strategy. The instructional program, called, "Building Coping Skills on a Firm Foundation," begins by offering nine categories of college student stress: instruction; competition; managing time; adjusting to college; administrative problems; social adjustment; finances; housing; and transportation. The metaphorical GUI for this program provides for engagement, orientation, familiarity and transfer, and coherence. The primary metaphor for this program is a building construction site. In addition to the use of primary and secondary metaphors, the program uses color selectively to focus the learner's attention. Upon completion, the program will be tested to determine if the metaphorical GUI contributes to the students' understanding of the relationship of time management to coping with stress. (Contains 25 references.) (AEF)

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Title:

Building Coping Skills on a Firm Foundation: Using a Metaphorical Interface to Deliver Stress Management Instruction

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In 1986, when the concept of a graphical user interface (GUI) was still new, Norman challenged designers of computer-based programs to heed the needs of the user. He contended that interface design should stand separate from the needs of the system; in fact, the system should be "transparent" to the user. As far as the user is concerned, Norman argued, the interface *is* the system.

Ten years later, GUIs are everywhere. Apple Macintosh and Windows desktop GUIs dominate the market. Software developers vie to see who can release the "more graphical" program. Users now recognize icons and buttons as staples of most interfaces, and many, especially the young, have grown increasingly sophisticated in their taste for attractive interface design.

Utilizing Metaphors in the Graphical User Interface

Laurel (1993) contended that "an interface is not simply the means whereby a person and a computer represent themselves to one another; rather it is a shared context for action in which both are agents" (p. 4). As graphics have become increasingly more sophisticated and dominant in the human-computer interface, they offer users opportunities to process and interact with information in ways likely to be richer than text alone. Brown (1988) asserted that an important advantage of graphical presentation is in increasing the rate at which users can process, understand, and respond to a display. But the presence of graphics alone does not assure Norman's "transparent" interface. In fact, including graphics may actually make the interface less comprehensible. Increasingly complex graphics, like the sirens of mythological fame, lure us ever closer to foundering and failure. But, if graphics, in and of themselves, do not enhance comprehensibility and help users understand how to make the most of a program's promise, what does? Perhaps metaphorical interfaces do.

A metaphor is a figure of speech which applies its symbolic images to a subject, to improve our understanding of that subject by linking the familiar with the unknown. Paivio (1979) argued that a metaphor acts as a *vehicle* when used in conjunction with another object, a *topic*, to impart a similarity or relationship which helps render the new knowledge we are acquiring intelligible. Lakoff and Johnson (1980) asserted that metaphors are a pervasive part of our speech and thought, used to understand and experience one kind of thing in terms of another. Erickson (1990) agreed, suggesting that metaphors are invisible webs of terms and associations that underlie the way we communicate.

Metaphors can convey rich images and chunks of information that hold more meaning than the literal definition or singular implication of the phrase used as a vehicle. When people perceive the presence of a metaphor, they explore a range of potentially applicable emotions, sensations, and mental images. This range and its components appear different for each individual, but are tied in some way to individual experiences and imaginations, helping to build individual cognitive models (Lakoff, 1987; Ortony, 1979; Petrie, 1979). In fact, Black (1979) contended that "every metaphor is the tip of a submerged model" (p. 31). But the model's existence does not mean that the user must accept the complete package of implications for the metaphor to work. Rather, Black argued, the perceiver selects, organizes, projects, and suppresses portions of the metaphor as needed to facilitate comprehension and, at the same time, codes both the topic of the metaphor and the vehicle into long-term memory (see also Mountford, 1990; Paivio, 1979).

According to Rieber (1994), graphics in the computer interface can take a number of forms, particularly for computer-based instruction. They can be arbitrary, like a graph which illustrates a logical or conceptual relationship. They can be representational, like an illustration of two people having an argument. Or they can be analogical, as when an image of two knights squaring off in a jousting match represents two people in an argument. Analogical graphics might also be described as visual metaphors. Visual metaphors in interfaces can share the same properties as the ones we use in speech, according to Dent and Rosenberg (1990). The authors argued that as a verbal metaphor acts as a vehicle to describe or explain a less familiar topic, a visual metaphor depicts a vehicle object using properties that are recognizably related to the topic object. As illustrated in the clip art cartoon of Figure 1, the most important properties, those which exemplify the connection between vehicle and topic, are emphasized in the visual metaphor. The vehicle, an office worker, is revealed by just a few properties: a desk, chair, and typewriter. His dilemma is indicated by the sweat pouring off his brow and the canoe heading over the falls. The state of "teetering on the brink" is a metaphor for the topic, apparently a deadline that is fast approaching.

Graphical user interfaces can integrate images more fully than just an occasional spot illustration. They can employ icons, small graphical representations to indicate interactive objects,

actions, or concepts. GUIs can also utilize large graphical images to represent something other than the actual computer screen. Those large graphical images can be integral to the meaning and the action of a computer program, and they can be metaphorical in nature.

What a metaphorical GUI has to offer

Engagement. Laurel (1993) contended that an interface metaphor can serve as a "mimesis," a functional representation that encourages the user to become engaged, to participate, to willingly suspend his or her disbelief as we do for movies and plays. Such a metaphor, which Keller (1983) called a metaphoric organizer, can grab the user's attention while acting as an advance organizer for the actual content, in a sense planting clues for the user to pick up, developing a sense of expectation. Keller argued that using such an organizer can help students relate a more abstract concept to a familiar, concrete one, build curiosity, and add to an effective learning experience.

Orientation. A metaphorical interface may help users learn how to use a program or system. Unless we design it carefully, however, an opposing disadvantage might be that the metaphor could break down as the novice learner moves toward expertise, developing an understanding of the system or program that can extend beyond the metaphor's utility (Laurel, 1993).

Familiarity and Transfer. Hammond and Allinson (1987) asserted that a primary strength of metaphors lies in their familiarity. The authors developed and tested a "travel holiday" metaphor to aid users in navigating a general knowledge base. Their results suggest that once the user has established the primary relationship between the metaphor and the topic to which it relates, secondary relationships can be more easily established as the user retrieves familiar knowledge and actions from the metaphor's domain. They termed this "piggy-backing." The authors argued that metaphor use reduces the need for inference and logical thought. Plausible but erroneous mappings of the metaphor to the topic can, however, occur if the designer has not considered such mappings and their causes in advance. A designer who has so considered potential mismappings should be able to suggest additional useful aspects of the metaphor to decrease the likelihood of their occurring.

Bielenberg (1993) concurred, asserting that visual metaphors in GUI instructional programs can be one of the most powerful ways to transfer meaning. He used as an example a "Test Drive" program, designed with a metaphor of a car dashboard and driver controls to convey technical information about the capabilities of digital video interactive (DVI). Bielenberg contended that a user who is familiar with automobiles brings to the instructional program a mental model of the functionality of the car's dashboard and controls. The designer offers a conceptual model, a structure composed of the content to be taught, the task to be performed, or the information to be displayed. The purpose of the interface, according to the author, is to encourage the user's mental model to conform to the designer's conceptual model quickly, completely, and painlessly. He asserted that visual metaphors can support that process and urged designers to analyze the needs of the learner and the structure of the content when choosing a visual metaphor.

Coherence. Providing coherence is another advantage of integrating a metaphor into the interface, according to Laurel (1993). If the metaphor is well-chosen, all of the elements of a program or system should cohere naturally, for example, as files in the Macintosh desktop fit into folders. Cates (1994) refers to this as the presence of complementary auxiliary metaphors, in this case to accompany the underlying metaphor of a desktop. Of course, limitations of this metaphor's implementation become evident when users begin to look for other "items" they expect to see on the Mac desktop, like staplers and paper clips, and fail to find that functionality, or when they find a trash can on top of their desk. This latter example is an instance of a confounding auxiliary metaphor (Cates, 1994).

Implementing a Metaphor to Deliver Instruction on Stress Management

The pervasiveness of stress in our lives makes stress management a popular topic. Selye (1981), considered the father of modern stress theory, contended that stress is inevitable. Without it we would suffer from a lack of motivation and drive. Many workshops, books, and tapes exist on stress management, and many techniques to reduce or cope with stress have met with varying degrees of success.

Any adult who remembers his or her college years as idyllic and stress-free is probably exhibiting a case of selective memory. According to Benjamin (1987), college students, particularly freshmen, face many new responsibilities. Among them are organizing their time, handling new social and administrative interactions, adapting to large numbers of students who are unknown to them, and often facing much more rigorous academic performance standards. Stress naturally accompanies these new responsibilities. A recent World Wide Web report by the Counseling Center of the State University of New York at Buffalo (1995) listed stress periods for students by month. Every month of

the student's academic year held a bulleted list of at least four stressors or stress reactions based on academic and other aspects of normal college life.

Computer-based instruction on stress management

A computer-based instructional (CBI) program about stress management could be quite large, since stress ideally should be managed on a number of levels -- physiological, cognitive, emotional, and behavioral (Roskies, 1987). In order to narrow the field to a manageable size for testing the implementation of a visual metaphor, the researchers have chosen to develop a CBI lesson for college students on 1) the fundamentals of stress, and 2) the role of time management as a coping strategy. The fundamentals of stress include building an awareness of specific sources of stress for college students, and identifying ways to cope with stress by managing it effectively, utilizing available support mechanisms. The portion of instruction on time management will attempt to validate a model developed by Brown (1992). Brown suggested that students first map the time allotted for various activities against the available time in each week. Next, they evoke memories and a visual representation of the past semester's peak stress periods. Last, they practice ways to handle moderately increased stress now in order to reduce it significantly later.

Description of content

The instructional program, called "Building Coping Skills on a Firm Foundation," begins by offering nine categories of college student stress (Johnson, 1978): instruction, competition, managing time, adjusting to college, administrative problems, social adjustment, finances, housing, and transportation. Students are informed about the particular relevance of stress and stress management to their lives. Students then examine how to react to the addition of a new stress factor and explore the relationship of balance in the realms of physical health, psychological health, academic obligations, and social life (including the support of friends, faculty, and professionals) to coping with stress. They learn about the forms that stress can take, and add personal descriptors of physical and emotional signs of stress.

Beginning a decision-making exercise involving a proposed new stress factor, students chart a weekly schedule, dividing hours of the week into categories for sleep, eating, classes, and other components. They note the number of hours left for study and compare them to an ideal. Given the added stress factor, students practice coping by adjusting their schedules, assessing the effects of their adjustments on the various components. Feedback offers pros and cons about those adjustments (for example, the effects of inadequate sleep). The program analyzes the results in terms of a healthy balance of physical, academic, social, and psychological needs and provides a running stress assessment report. In a final metacognitive exercise, students select the ten ideas most useful to them from a given list of ideas about how to improve time management skills for study and living. They select and drag them to a report form, adapt them, add new ideas, and print out the resultant form.

The role of a metaphorical GUI for this program

Engagement. Many of us view the efficacy of our actions on a daily, even moment-by-moment basis, rarely taking the time to step back and take a long view. Most of us feel that at any given time we are doing the best we can. Though stress is neither the province of the young nor the old, college students can often find themselves in difficult and stressful situations, compounded by their youth and inexperience. Brown (1992) discussed the motivational conflicts students can face when they confront at least two simultaneous choices. One is usually academic in nature, with delayed reward (grades) and remote consequences (positive or negative reinforcement in the classroom, future career choices). The others are often social activities, with immediate reward (exercise leading to a sense of physical well-being, the pleasures of food and drink, positive reinforcement from friends). Given a natural tendency to be short-sighted, some students might predict that an instructional lesson on stress management would be dry, "preachy," and an inaccurate reflection of their lives. Introducing the lesson with a metaphorical GUI before they meet the lesson's content could serve the purpose of engaging learners, as Laurel (1993) argued, to participate, to buy in, and to suspend their disbelief. The metaphor should be concrete, comprehensible, and familiar enough to all college students that it would not cause cognitive dissonance nor lose the audience. Learners should suspend their disbelief on participating in the "mimesis" willingly, not reluctantly.

Orientation. As with most instructional computer-based programs, there are uniform conventions of use, like a stop or quit function, the ability to navigate, and expected responses to data input. But there are also unique elements in the functionality of any program. A metaphorical GUI could help learners become oriented to both predictable and unique functions by placing all functions in a consistent context. For example, elements of the metaphorical interface could indicate properties of use, such as a "report" in which data can be entered, or a set of binoculars which could magnify a view or provide deeper insight. Expected functions could be portrayed in ways consistent with the metaphor; for example, a building construction site might display its stop function in the form of an EXIT sign on the fence surrounding the site.

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Familiarity and Transfer. We have already noted that our lives seem intimately familiar to us. Yet life can hand us lemons and, at any given time, we may have greater or lesser abilities to make lemonade. Similarly, the subject of stress and our ability to cope may seem familiar territory, yet it may not be as familiar as we think. Lakoff and Johnson (1980), paraphrasing Aristotle's Rhetoric, suggested that metaphors are one of our most important tools for trying to comprehend partially what cannot be comprehended totally -- our feelings, aesthetic experiences, moral practices, and spiritual awareness. A metaphorical GUI portraying a familiar setting, situation, or event can offer a more concrete framework to help learners acquire new ways to picture what may not be comprehended totally. In effect, the metaphor can provide learners with a conceptual fix on what may always be a moving target, as feelings change constantly and stress levels ebb and flow. The designer can encourage learners to bring their mental model of the metaphorical GUI to the instructional event, as Bielenberg (1993) suggested. The learner's mental model, or schema, should support his or her new understanding of the topic if the designer's conceptual model of the content is mapped well to the needs of the program's users and to the metaphorical GUI.

A mental model may be particularly important to the content in this case because the chosen lesson focuses on relational concepts: a balance of finite resources (time, health, academic requirements), personal responses to stressful situations, and decisions affecting short- and long-term goals. For college students, stress can be found in as many as nine categories. Each category can be perceived as a layer that each student must handle, and the weight of those layers can pile up intensively and with disastrous consequences, should the student not have a strong enough "foundation" to bear the weight. In addition, each individual has a propensity to respond in a number of different ways. Some may tend to ignore the problem until they sink under the weight. Others may put a temporary "patch" on the situation, risking future complications, while others will stop and focus long enough to assess the problem and address it as definitively as possible. In this case a visual metaphor could build a fitting mental model to help learners transfer their new knowledge to future stress-related events beyond the scope of this lesson, helping them imagine ways to adjust those relationships in order to successfully cope with new problems.

Coherence. Finally, a metaphorical GUI can provide this stress management program with visual elements that tie the metaphor to the content throughout the lesson, providing a sense of coherence and reinforcement for the functionality of the learner's mental model in representing the content. All elements of the metaphor should logically and coherently support the lesson, including the presentation of information, the exercises, feedback, reports, and opportunities for practice. All auxiliary metaphors should, therefore, be complementary.

Components of the metaphor

For this program, "Building Coping Skills on a Firm Foundation," the primary metaphor is a building construction site. The learner enters the program as a new manager of building construction. The building, a new student center for the fictional Piloton University, consists of a foundation and a number of framed-out stories. As the brief story line develops, you, the new manager, are made aware by other employees that your boss, Ike N. Cope, has authorized the addition of four more layers, or stories, to the building. Figure 2 shows the building under construction. The building represents the life of a student, supported by a foundation of physical health, and including layers, or "stories" of stress factors, including academic requirements, competition, financial pressures, and other components listed above.

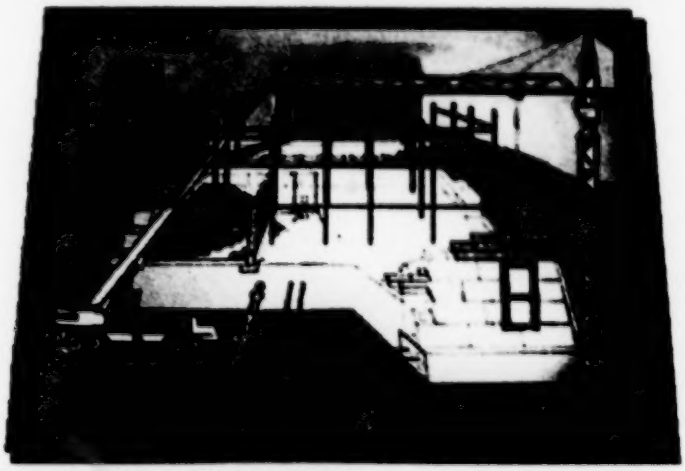

Figure 2: Building under Construction

The manager, of course, manages construction of the edifice, just as learners manage, with greater and lesser degrees of success, the components of their lives as college students.

As the introductory plot develops, another coworker points out that there is a problem in the building's construction. A crack has appeared in a support beam, and a connected beam has started to bend. The coworker implies that there may be a problem with the foundation, particularly if it must support the weight of additional floors. As manager you are faced with an immediate choice: to ignore the construction problem, to "patch" it, or to stop construction briefly (for everyone's safety) and plan the best way to deal with it. Animation sequences and "faxed" feedback from the remote boss can demonstrate the results of these choices to the primary metaphor, the building and its foundation. As the program moves from the metaphorical GUI's story to a more content-intensive lesson, learners will again face this dilemma as an unexpected theoretical stressor is added to their lives, forcing them to examine the results of the same coping choices: ignore, patch, or manage it. Feedback is again given, reflecting the images and language of the primary metaphor. Thus, the tools of the metaphor come to be the tools of use in the realistic setting, a form of near transfer.

To help designers develop metaphorical GUIs that effectively support instruction, Cates (1994) suggested a method for identifying related properties of a primary metaphor. Called a POPIT approach, this method identifies a prospective metaphor's properties, operations, phrases, images, and types. A POPIT approach can reveal bad news and good news. The good news may be that a metaphor offers a rich environment of secondary metaphors, consonant components to support acquisition of new knowledge. The bad news may be that a component of the metaphor is dissonant, leading to rejection either of that component or –if it can't be ignored– the whole metaphor. However, the bad news is actually good news for the learner, who will have avoided a potentially irritating learning experience.

A POPIT of the building construction site metaphor revealed a number of useful secondary metaphors. One, a blueprint, shown in Figure 3, indicates the four extra floors that should be added to the student center. Each floor contains rooms or offices representing some of the stressors typically faced by college students: academic requirements, financial needs, career, and so forth. The top level, a recreation center, represents the need for friends and relaxation time, but can also represent a source of stress if time dedicated to recreational activities (and recovery time for some of them) is not managed reasonably.

Figure 3: Blueprint

While the physical factors are represented by the building's foundation, Figure 4 reveals auxiliary metaphors for the three other factors of college student life that require balance in order to manage stress: psychological health, academic obligations, and social life. "Your" hand holding a pocket watch and a list of problems that must be addressed represents academic obligations. Some workers at the construction site represent auxiliary metaphors for social life. The lower right corner of Figure 4 shows four construction workers helping each other by carrying two beams between them, representing the support of friends. Another worker sits on a beam bearing the American flag. He's waving and happy, motivated to do his job well and with pride. This worker is an auxiliary metaphor for psychological health. Though this

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lesson focuses primarily on time management as a coping strategy for the strain of additional stressors, the other elements are noteworthy and necessary. To illustrate the relationship of all four factors to each other, the learner is presented with a conundrum: what if the foundation's strong, your project is on time, the teams are working well together, but a few workers are depressed? What if any other one of these factors is out of kilter? This same kind of conundrum reoccurs later in the instruction, this time dealing with actual content. Reinforcement is provided as the

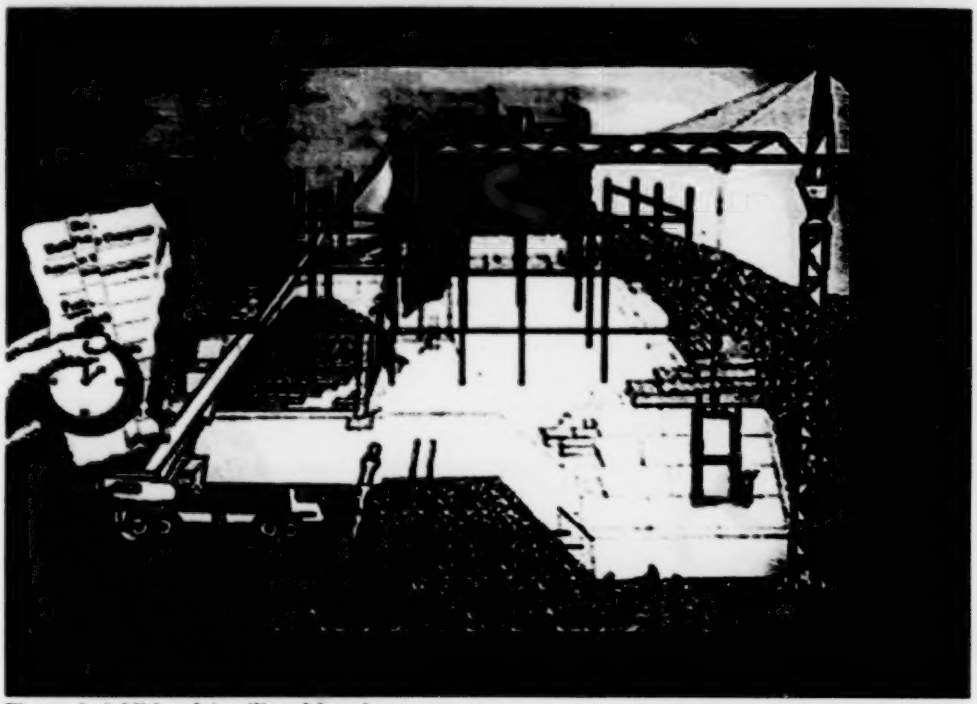

Figure 4: Additional Auxiliary Metaphors

content is tied to the appropriate metaphoric images.

Besides the blueprint, the workers, and the pocket watch, another set of auxiliary metaphors, business forms, provides coherence to this program's functionality. As mentioned earlier, after students are given a new stress factor they are presented with a decision-making exercise in which they practice how to manage their time. They take a comprehensive look at the hours they spend at various activities, dividing the hours of the week into categories. They practice coping by adjusting their schedules, and receive feedback in the form of a stress assessment report. Finally they develop a report containing ideas about how to improve their time management –and thus coping– skills. Doing this exercise requires three forms, shown in Figure 5 below: one for students to chart and adjust hours spent, one to provide feedback to the learner, and one for each learner's personalized coping ideas. As auxiliary metaphors, these forms can take the guise of a spreadsheet, a stress assessment report (a play on words for "stress" as a strain to the foundation and beams), and a memo.

Visual reinforcers

In addition to the use of primary and secondary metaphors, this program uses color selectively. Primarily black and white, the metaphorical GUI uses select areas of color to focus the learner's attention. For example, on the screen in which a coworker indicates to the manager that there is a construction problem, the only item containing color is a set of binoculars the coworker offers to the manager. In Figure 4, only the team workers, the pocket watch, and the worker with the flag are colorful. The learner's eye is directed by color and by text cues to attend to selected portions of the screen. This treatment has the added benefit of rendering the computer program a more manageable size without giving up important design elements.

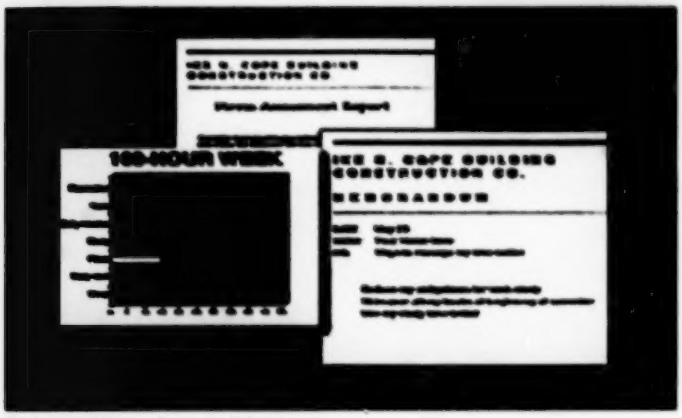

Figure 5: Spreadsheet, Report, Memo

The Field Test

Upon completion, "Building Coping Skills on a Firm Foundation" will be tested with a sample population of approximately 150 college students, both freshmen and upperclassmen, to determine if the metaphorical graphical user interface contributes to the students' understanding of the relationship of time management to coping with stress. The program will be tested in two formats: half of the sample will utilize the program with content tied into a metaphorical GUI, while the other half will use the format containing the stress management content without a metaphorical GUI.

"Building Coping Skills" will be validated by a group of experts on stress management for college students. This group will confirm that the metaphorical implementations have content and construct validity, particularly for Brown's (1992) model for time management. They will also help to derive the optimum "healthy" balance of physical, academic, social, and psychological needs. An initial pilot test will be conducted with a small group of college students to help improve interface and implementation effectiveness. The researchers will interview students for feedback on comprehensibility of the subject matter, clarity or ambiguity of visual images, accuracy, ease of use, and relevancy.

After the program is revised based on the evaluators' feedback, it will go to a main field test. The program itself should take approximately an hour to complete. Faculty or other observers who supervise the program's delivery will be trained for inter-rater reliability to assess the performance of each student on completion of the program. In addition, the computer system will retain performance logs of student usage (audit trails). Students from both groups may participate in pre- and posttests to measure individual differences in levels of anxiety as indicated by the State-Trait Anxiety Inventory. The researchers may also test for visual versus verbal cognitive styles, to determine if there is a correlation with the ability to internalize and utilize a new mental model (Jonassen & Grabowski, 1993). A posttest questionnaire will again elicit reactions to comprehensibility of the subject matter, clarity or ambiguity of visual images, accuracy, ease of use, and relevancy. Finally, two weeks later, the researchers will conduct follow-up interviews of a subset of students to determine if the construction site metaphor succeeded in building a lasting mental model. When these students are asked about friends suffering from stress, will they incorporate terminology and analogies from the construction site metaphor in their responses?

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